

# High Voltage Regulated PSU

**Construction**

This project grew from three basic requirements. The first came from a need to regulate the unusual voltage required for a valved radio under repair. The second arose from a need to supply power to the *PW Empire* four valve QRP transceiver published in the 1000th issue of *PW* and finally, just to experiment with the idea of a high voltage transistor regulated p.s.u.

## BEGINNINGS

The original was used to power a valved receiver which had 'blown' both the original transformer and the (gas-filled) stabiliser valve. For those of you who have not met one of these, they are in effect a neon (and/or other rare-gas) filled valve, which acts in the same way as a Zener diode. The Zener diode shown (D5) in the circuit diagram could have admirably fulfilled this function, as the current requirement was small, about 5mA, in total.

## SECOND TASK

The second requirement however, was somewhat more than the Zener diode would have been able to cope with. The *PW Empire* required a maximum current of about 20-25mA under full loading. This would have required a Zener diode of at least 2W dissipation. So I felt some form of active regulator was a better option. A simple voltage buffer (emitter follower) circuit was tried, and rejected the first time I inadvertently shorted the output leads together. Both the transistor and the Zener diode mutually self-destructed and I felt rather foolish.

Clearly some form of current limit was required for the circuit, but a design in which the full rectified voltage could be applied across the regulating transistor without damaging it.

## REFERENCE LEVEL

The first two requirements, modified by the third, resulted in the circuit shown in the diagram Fig. 1. The Zener diode (D5), has been demoted to merely acting as a reference for the emitter of the difference amplifier TR1. By this means the emitter of TR1 is held at approximately 100V and a portion of the regulated output is fed to the base of this transistor, via limiting resistor R3. Transistor TR2

acts as an emitter follower to the corrected output voltage at the collector of TR1. Both of these transistors have to be able to withstand the whole of the rectified voltage, present across the reservoir capacitor C1. They are both high voltage types. Don't try to use any other types unless the devices you wish to substitute have a  $V_{CE}$  of greater than 300V.

## CURRENT LIMIT

The current limiter transistor TR3 has no similar voltage limitations placed upon it and almost any small signal type could be used in its place. The maximum voltage across this is around 1.5V (just prior to limiting), and the maximum current carried would be about 3.5mA under total short circuit conditions.

As the total supply current flows through R4, the voltage across it will start to rise as the load current increases. At the point at which this voltage rises above 0.6V, TR3 comes into conduction, bypassing the base current of TR2 to the output connection. This continues to a point at which the base current of TR2 becomes fixed, allowing only a limited output current to flow.

Table 1 has list of values for R4 at various limiting current levels. I don't recommend that you have limiting currents in excess of 100mA, as 25-30W may be dissipated by TR2 under short circuit conditions at those levels.

## CONSTRUCTION

It's advisable to build this project on the designed board available from the *PW PCB* service. The prototype however, was built on perforated matrix board which is just adequate for the purpose. A mistake at these voltages could be expensive (and possibly fatal). The on-board transistor, TR2 is mounted with the metal plate uppermost for heatsinking purposes. You should take great care that the leads of the transistor don't touch the heatsink. You should also take great care, when the unit is in operation, to avoid touching the heatsink yourself, as it is at 300-350V potential.

Note: If the current limit is set at less than 50mA then only half of the heatsink area is required, but above this level all of the heatsink is needed.

*Are you worried about using transistors for a high voltage regulated power supply? Niel Starkie dispels the doubts and shows that it's really quite easy.*

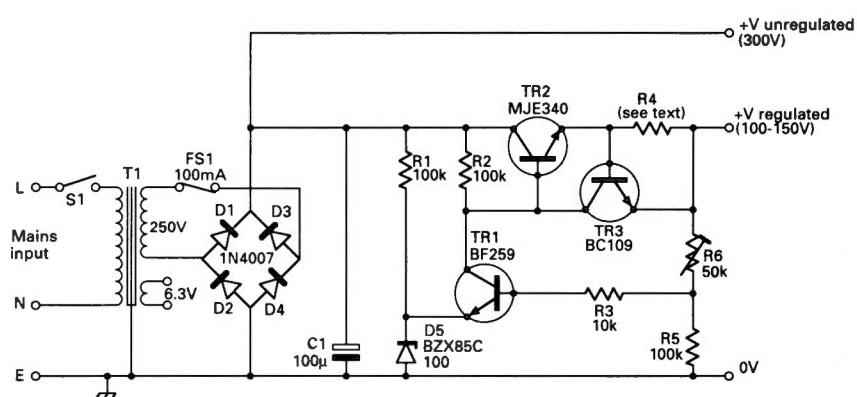
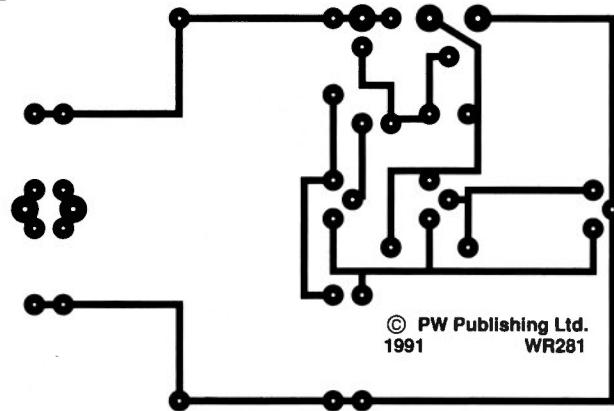


Fig. 1: The circuit diagram of the regulator, note the simplicity, the p.s.u. has only one capacitor.

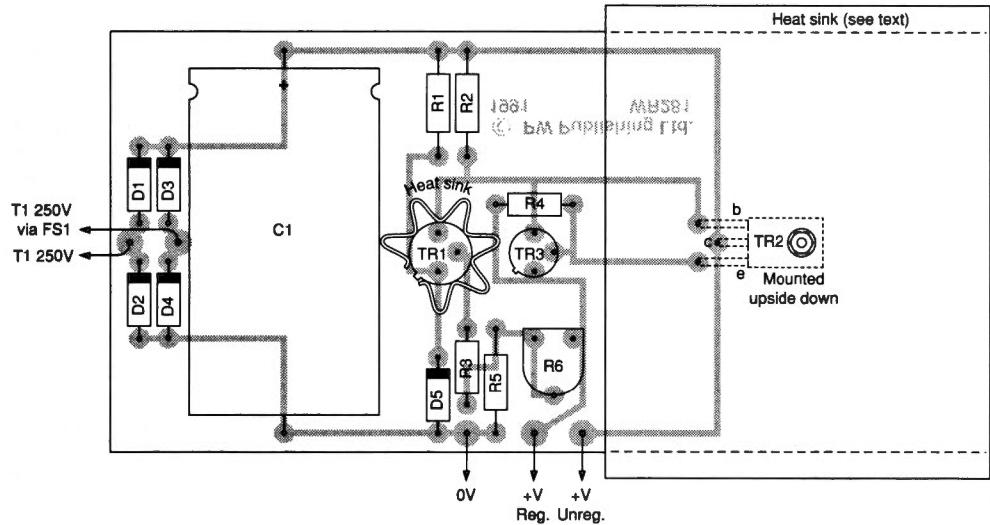
Table 1

Current Limit	R4 value	load resistor	Min.power rating
5mA	120Ω	27kΩ	1W
10mA	68Ω	15kΩ	1.5W
15mA	47Ω	9.1kΩ	2W
20mA	33Ω	6.8kΩ	2.5W
25mA	27Ω	5.6kΩ	4W
50mA	12Ω	2.7kΩ	7W
75mA	8.2Ω	1.8kΩ	10W
100mA	6.8Ω	1.2kΩ	15W

**Fig. 2: The track pattern and overlay diagram of the regulator p.c.b.**



**WARNING:**  
**POTENTIALLY LETHAL VOLTAGES EXIST WITHIN THIS UNIT.**



**How Much? £28+**  
**How Difficult? Intermediate**

### Shopping List

**Resistor 5% 1W**  
100kΩ 3 R1,2,5

**Resistor, 5% 0.5W**  
10kΩ 1 R3

**Variable potentiometer (horizontal mount)**  
47/50kΩ 1 R6

**Capacitor electrolytic (400V working axial leads)**  
100μF 1 C1  
(Electromail order No. 105-284)

### Semiconductors

**Diodes**  
1N4007 4 D1-4  
BZX85C100 1 D5  
(100V 1.3W Zener diode)

**Transistors**  
BC109 1 TR3  
BF259 1 TR1  
MJE340 1 TR2

### Miscellaneous

Valve transformer (250/6.3V)  
Maplin type XP27E, p.c.b. (see  
PW services page), 100mA  
fuse and holder, heat-sinks:  
Maplin type FL78K for TR1,  
type FL14U for TR2 (see text).  
An assortment of screws,  
washers and nuts to suit, a  
suitable earthed and/or  
insulated box to contain the  
unit, interconnecting wire of  
suitable high voltage grade.  
Capacitor C1 is available (in  
packs of five only) from RS  
Components or Electromail.  
You may be able to obtain one  
from your local electronics  
supplier by asking them to  
'split' a pack, in return for a  
small surcharge on the price  
of a single item.

Maplin Electronics., P.O. Box  
3, Rayleigh, Essex SS6 8LR.  
Electromail, P.O. Box 33,  
Corby, Northants NN17 9EL.

Mount capacitor C1 last after double checking the placing and orientation of all other components. Double-check that capacitor C1 is also correctly placed and orientated. You should bear in mind that it could explode with some violence if wrongly connected.

### Testing

If all is well set the preset resistor R6 to about mid-travel position and switch on. A voltage of about 350V should be present at the unregulated output and about 125V at the regulated output. If not, switch off and investigate. The regulated output should be variable between 100-150V approximately.

Finally you should set the output to 125V. Using a suitable resistor, in both power handling and resistance value, load up the regulated output to just under the limiting value (Table 1 has values and power handling requirements of this resistor). The output should drop by only one volt or less. The p.s.u. is now ready for use in a suitable surrounding box or case.

PW